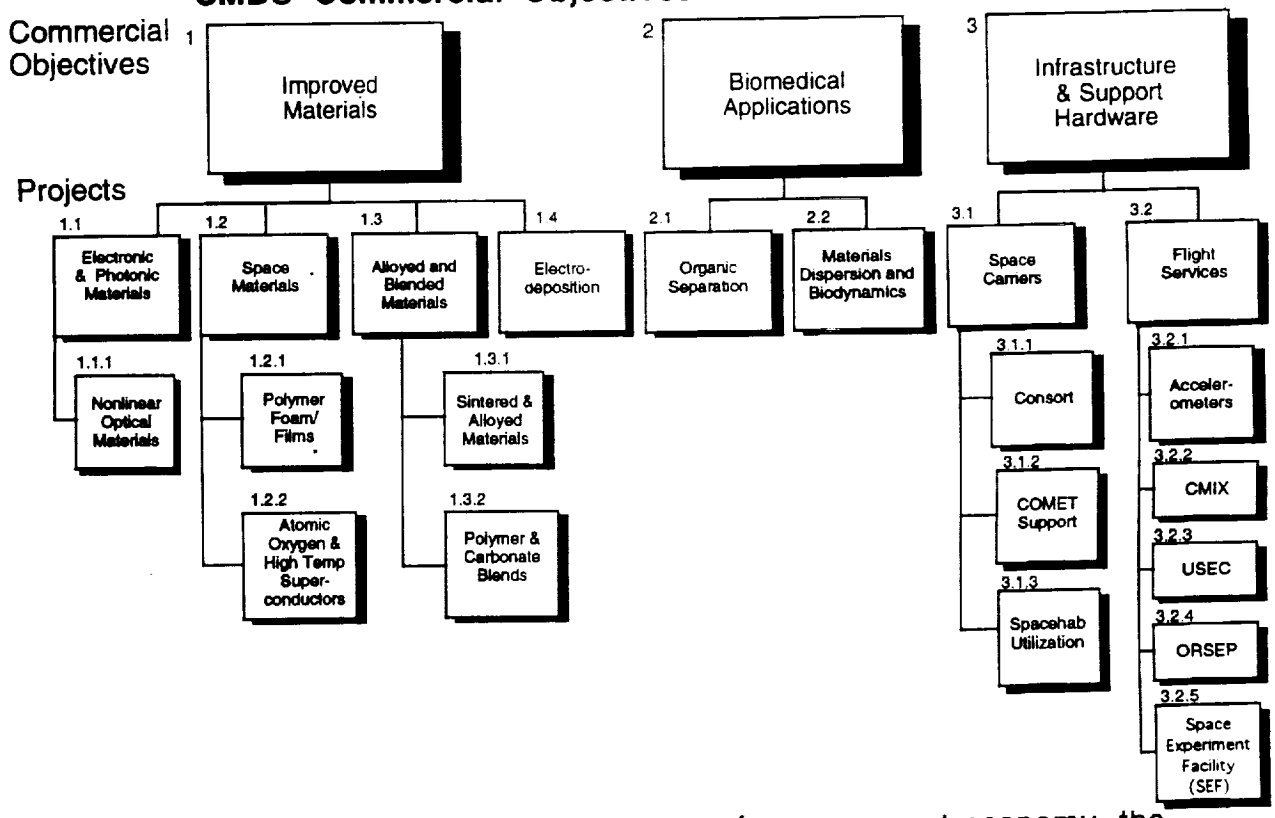
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

CONSORTIUM FOR MATERIALS DEVELOPMENT IN SPACE NAGW-812

Annual Technical Report (Fiscal Year 1993)

During fiscal 1993, the Consortium for Materials Development in Space (CMDS) maintained the organizational structure and project orientation established in prior years. The active projects, as depicted in the Commercial Objectives Work Structure (COWS) chart (Figure 1), were only slightly modified during the year.

Figure 1
CMDS Commercial Objectives Work Structure



Late in the year, to achieve an element of management economy, the High Temperature Superconductors and Atomic Oxygen projects were merged into a single project. This merger recognizes that the projects had evolved into a close relationship, particularly the emphasis on using an atomic oxygen beam to achieve the desired oxidation state for superconductors.

The project to achieve a suborbital rocket capability with a microgravity time greater than 12 minutes (Joust/Spartan) was put in a "hold" status late in the year due to limited budgets expected for FY'94 and subsequent years. However, a CMDS-organized meeting with White Sands Missile Range officials and rocket vehicle contractor personnel indicated that a "Maxus"-type mission could probably be accomplished safely at White Sands. The vehicle for such an extended flight mission would be a Castor-IV-B rocket motor and a Consort-like payload configuration. Such a vehicle was flown successfully in Europe and the CMDS could easily initiate similar flights for the CCDS's in the U.S., if funds were available. The potential for such flights will be carried in the coming year as an option under the Consort Project, since the payload configuration would be the same.

An alternative to a White Sands launch could be from an oil drilling platform off the coast of South Alabama. This option also was studied, funded by $50,000 from the State of Alabama. The study included other missions in addition to the "Maxus"-type. Launches from an oil platform seem technically feasible but, again, funding to develop that capability is not currently available.

The Polymer and Carbonate Blends project might more accurately be called Polymer and Cement Blends. It remains in a tentative status. However, during FY'93 a workshop was held with industry and Marshall Space Flight Center personnel to explore the utility of such materials for a lunar base. Also, the UAH chapter of *Students for the Exploration and Development of Space* (SEDS) is working with industry to prepare a 1994 Get Away Special carrying a microgravity cement project. The CMDS has an advisory role for this student effort, but it is not CMDS-funded. Depending on the outcome of the student/industry investigation, the CMDS might activate a follow-on project if resources are available.

With the exceptions just discussed, the CMDS projects during FY'93 continued essentially as planned. An important aspect of this is the list of space missions accomplished successfully. Figure 2 presents the FY'93 flights accomplished and the FY'94 payloads in preparation during FY'93.

In support of the Materials Dispersion and Biodynamics project, two CMIX missions were carried successfully by the Space Shuttle. These missions produced a diversity of valuable results. Due to funding constraints and personnel time limitations, the Materials Dispersion Apparatus (MDA) was not carried on Consort 6. The MDA project also flew samples on STS-54 in January 1993 under the BioServe CCDS.

Consort 6 flew successfully on February 19, 1993. It was a reflight (using insurance funds) of Consort 5 that had a rocket a rocket failure in September 1992. For the CMDS, it carried instrumentation for four materials projects: Polymer Foams and Films (2 experiments), Sintered and Alloyed Materials (2 experiments), Electrodeposition, and Organic Separation. It also carried a CMDS accelerometer system to support all investigations on the mission.

Figure 2
FY'93 CMDS Flights and Flight Preparation

	FY '93 FLIGHTS ACCOMPLISHED						FY '94 FLIGHTS IN PREPARATION DURING FY '93				
	CMIX-1	Consort 6	Spacehab-1	CMIX-2	Concap-IV-1	Other STS	COMET 1	Spacehab-2	CMIX-3	Concap-II-02	Concap-IV-02
Nonlinear Optical Materials					X		X				X
Atomic Oxygen/High-Temp. Supercond.							X			X	
Polymer Foam and Films		X*									
Sintered and Alloyed Materials*		X*	X					X*			
Electrodeposition		X									
Organic Separation		X	X					X			
Materials Dispersion & Biodynamics	X			X		X	X		X		
Accelerometers		X	X				X	X		X	

*Two experiments

The first Spacehab mission on the Space Shuttle (STS-57) occurred in 1993 carrying equipment for several of the CCDS's. This mission supported three CMDS projects: Sintered and Alloyed Materials, Organic Separation, and a spatially distributed accelerometer system.

The Nonlinear Optical Materials project flew six ovens for vapor transport crystal growth in a Get Away Special, CONCAP-IV-01, on STS-57.

COMET-01 had been scheduled for 1993, but has been postponed to 1994. Nevertheless, four experiment packages were completed in 1993 for the COMET flight: Nonlinear Optical Materials (a 3 oven unit), Atomic Oxygen, Materials Dispersion and Biodynamics, and an accelerometer system. The CMDS has been the technical monitor for the launch vehicle contract.

As mentioned above, the Organic Separation project flew on Consort 6 and Spacehab-01 and is in preparation for Spacehab-02.

The Space Experiment Facility, a three-furnace facility, procured by the CMDS from Boeing Commercial Space Development Company (Seattle), was delivered in November 1992 and ground tests, furnaces profiles, astronaut

delivered in November 1992 and ground tests, furnaces profiles, astronaut training, safety docuementation, etc. toward a Spacehab-02 mission are proceeding. The CMDS is the manager of the furnace facility and will utilize the opaque furnace on the Spacehab-02 mission for the Sintered and Alloyed Materials project. The Clarkson CCDS will use one of the transparent furnaces for a crystal growth experiment on the same mission. In addition to SEF, three other CMDS projects that will fly on Spacehab-02 (now scheduled for January 1994) are in preparation. They are reflights of the three Spacehab-01 experiments: Sintered and Alloyed Materials, Organic Separation, and an accelerometer system.

In summary, FY'93 has been the most successful year for flight experiments so far experienced by the CMDS. Preparations are in progress for an equally busy FY'94. The Consortium Council met four times in FY'93 to review and guide the CMDS activities. The August Council meeting immediately preceded the Peer Review of the CMDS organized by the Office of Advanced Concepts and Technology. Most of the CMDS industry members were represented at the Peer Review.

During FY'93, five new industry affiliates were accepted by the Council. They and their project associations are:

Displaytech, Inc.	Boulder, CO	Nonlinear Optical Materials
Synthecon, Inc.	Friendswood, TX	Materials Dispersion & Biodynamics
Automatic Switch Co.	Florham Park, NJ	Sintered & Alloyed Materials
Machined Ceramics	Louisville, KY	Sintered & Alloyed Materials
Parker Hannifin Corp..	Huntsville, AL	Sintered & Alloyed Materials

A list of publications and presentations in FY'93 is contained in Attachment 1. Two new patents were filed and notification of a patent award was received. One of the projects has generated a spin-off company, Shearwater Polymers. Three CMDS-supported students were awarded Ph.D.'s during FY'93 and one student received an M.S. degree.

Clearly, FY'93 has been an extremely active year for the CMDS. Many technical and business accomplishments were documented for the August Peer Review. These documents, which are cited in Attachment 1, are lengthy and are available as required. Therefore, they will not be reproduced here.

Attachment 1

Publications, Abstracts, Presentations: FY'93
Consortium for Materials Development in Space

Materials Dispersion and Biodynamics:

Publications:

1. Lewis, M.L. Materials Dispersion and Biodynamics Project. For CCDS Peer Review, August 18, 1993.

Abstracts submitted to the 1993 Annual Meeting of the American Society for Gravitational and Space Biology (ASGSB) based on results from CMIX-1 (STS-52) and CMIX-2 (STS-56):

1. M.L.Lewis, and J.M. Cassanto, Automated, multiple-sample Minilabs provide significant cell biology and space bioprocessing data from Shuttle middeck research.

2. M. Hughes-Fulford, K. Nelson, S. Blaug, C.G. Summer, B.D. Lukefahr, and M.L. Lewis. MC3T3-E1 osteoblasts grown in microgravity on STS-56 have reduced cell growth, glucose utilization with altered actin cytoskeleton and increased prostaglandin synthesis.

3. G.A. Neil, L.A. Love-Homan, C. Summer, D.W. Sammons, and M.L. Lewis. Human splenic B cell activation *in vitro* is not impaired by microgravity.

4. R. Gruener, R. Roberts, and R. Reitstetter. Exposure to microgravity alters properties of cultured muscle cells.

5. M.A. Principato, B.D. Lawless, and M.L.Lewis. Superantigen-mediated T cell receptor stimulation in zero gravity.

6. B.J. Klement and B.S. Spooner. Pre-metatarsal organ culture in microgravity.

Abstract submitted to the 1993 Annual Meeting of the American Society for Cell Biology (ASCB):

1. M.L. Lewis, M.A. Principato, B.D. Lawless, D.R. Morrison, W.C. Kapp, S.L. Strobl, and A.C. Ochoa. Effects of microgravity on leukocyte growth control and function.

Organic Separation (ORSEP):

Publications:

1. Van Alstine, J.M., N.L. Burns, J.A.Riggs, K. Holmberg, and J.M. Harris, 1993. Electrokinetic Characterization of Polysaccharide Coatings in Industrial Polysaccharide Chemistry, M. Yalpani Ed., ACS Symposia Series, American Chemical Society, pp. 296-309.

2. Van Alstine, J.M., N.L. Burns, J.A. Riggs, K. Holmberg, and J.M. Harris, 1993. Electrokinetic Characterization of Hydrophilic Polymer Coatings of Biotechnical Significance. Colloids and Surfaces., in press.

3. Bergstrom, K., K. Holmberg, J.A.Riggs, J.M. Van Alstine, N.L. Burns, T.P. Shuman, and J.M. Harris, 1993, Protein Rejection by Polymer Modified Surfaces. Colloids and Surfaces, in press.

4. Van Alstine, J.M. 1993. Role of KC-135 Aircraft in Developing Low Gravity Polymer Phase System Demixing and Bioprocessing Research. Materials Science on Parabolic Aircraft. Curreri, P.A. (Ed.), NASA TM 4456, pp. 41-47.

5. Van Alstine, J.M. Organic Separations (ORSEP) Program: Program and Spacehab-01 Flight Results, for CCDS Peer Review, August 19, 1993.

Presentations:

1. Van Alstine, J.M., 1993. Polymer Coatings to Control Interfacial Phenomena. Department of Biomedical Engineering, University of Alabama, Birmingham.

Electrodeposition Project:

Publications:

1. Baird, J.K. Newton's Law of Cooling. For CCDS Peer Review, August 18, 1993.

2. Guo, L. and J.K. Baird. Judging the Importance of Solutal Convection in Crystal Growth. For CCDS Peer Review, August 18, 1993.

3. Chen, J.S., and J.K. Baird. Role of Diffusion and Reaction in the Shelf-Life of Solid Propellants. For CCDS Peer Review, August 18, 1993.

4. Clunie, J.C. and J.K. Baird. Effect of Hydrostatic Pressure on Diffusion. For CCDS Peer Review, August 18, 1993.

5. Baird, J.K. and J.S. Chen, Journal of Materials Research. 8, 1455 (1993).

6. Clunie, J.C., J.B. Cain, and J.K. Baird. Chemical Processing at the Critical Point of Solution. For the CCDS Peer Review, August 18, 1993.

7. Dasarathy, H., C. Riley, and H.D. Coble. Analysis of a apatite deposits on substrates. Journal of Biomedical Materials Research. 27, 477 (1993).

8. Riley, C., B. Benson, and H. Abi-Akar. Electrodeposition of Nickel from an Aqueous Solution in Low Gravity. NASA Tech. Memo. 4456, pg. 71 (1993).

9. Riley, C., B. Benson, H.D. Coble, and G. Maybee. Particle Dispersion and Suspension in an Aqueous Medium in Low Gravity. NASA Tech. Memo. (submitted by request)(1993).

10. Riley, C., H.D. Coble, G. Maybee, H. Abi-Akar, H. Dasarathy, S. Hudson, and J. Lee. Electrodeposition. For the CCDS Peer Review, August 18, 1993.

Sintered and Alloyed Materials:

Publications:

1. Smith, J.E., S.L. Noojin, K.L. Hartman, J.G. Vandegrift. Study of the Gravitational Effects on the Rearrangement Stage of Liquid Phase Sintered Binary Metallic Alloys. For the CCDS Peer Review, August 18, 1993.

2. Smith, J.E., T.T. Miller. Microgrvity Processing of Dry Ceramic Mixtures. For the CCDS Peer Review, August 18, 1993.

3. Morris. T.A., 1992, "Design, Integration, and Operation of a Process for Preparing a Silicon Carbide Whisker-Reinforced Alumina Composite in Microgravity," Master Thesis, University of Alabama in Huntsville, Huntsville, AL.

Atomic Oxygen & High Temperature Superconducting Materials:

Publications:

1. Gregory, J.C., G.N. Raikar, J.A. Bijvoet, P.D. Nerren, W.T. Sutherland, A. Mogro-Campero, H. Kwok, I.D. Raistrick and D.W. Cooke. High Temperature Superconducting Materials Improvement in Space.. For the CCDS Peer Review, August 18, 1993.

2. Gregory, J.C., G.P Miller, G.N. Raikar, L. Pay, P.J. Pettigrew, E.K. Newton, J.A. Bijvoet, P.D. Nerren, D. Wilkes, K. King. Longevity of Materials in Space. For the CCDS Peer Review, August 18, 1993.

Polymer Foams and Films:

Publications:

1. McManus, S.P. Foam Formation. For the CCDS Peer Review, August 18, 1993.

2. Wessling, F.C., S.P. McManus, D. Lester. Five Year Review of Foam Formation in Space. For the CCDS Peer Review, August 18, 1993.

Nonlinear Optical Materials:

Publications:

1. Leslie, T.M., W.C. Carswell, S.T. Kowel, M. Sanghadasa, P. Wang, M. Zugrav. Crystalline and Thin Film Materials for Optoelectronics. For the CCDS Peer Review, August 18, 1993.

COMET Program Support:

Publications:

1. Wessling, F.C., M. Robinson, R.S. Martinez, T. Gallimore, N. Combs. COMmercial Experiment Transport--COMET. For the CCDS Peer Review, August 18, 1993.

Consort:

Publications:

1. Naumann, R.J. Consort Program. For the CCDS Peer Review, August 18, 1993.

Accelerometers:

Publications:

1. Bijvoet, J.A., J. Blakely, P. Nerren, D. Wingo, J. Randorf, J. Weber. CMDS Microgravity Measurements Program, 1992 - 1993. For the CCDS Peer Review, August 18, 1993.